SPECIAL PRECAUTIONS FOR MULTIPLE SHORT-DELAY BLASTING IN COAL MINES

By John Nagy, Irving Hartmann,
and Robert W. Van Dolah

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CONTENTS

	Page
Summary	1
Introduction	1
Acknowledgments	2
Recommendations	2
General	2
Face preparation	2
Support of coal	4
Depth of cut	4
Number of shotholes	4
Depth of shotholes	4
Blasting supplies	5
Charging shotholes	5
Time delay	5
Preparation of the primer	5
Electrical connections	6

ILLUSTRATIONS

Fig.		
1.	Testing continuity of series circuit for short-delay blasting	3
2.	Testing for carbon monoxide after short-delay blasting in coal	4
3.	Preparation of primer and charging shothole for short-delay blasting	6
4.	Use of jumper wire to complete shot-firing circuit	8

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SPECIAL PRECAUTIONS FOR MULTIPLE SHORT-DELAY BLASTING IN COAL MINES[1]

by

John Nagy,[2] Irving Hartmann,[3] and Robert W. Van Dolah[4]

SUMMARY

This circular has been prepared for the guidance of safety engineers, shot firers, and coal-mine inspectors concerning multiple blasting with short-delay (millisecond-delay) detonators. These special precautions are suggested in addition to those normally followed in blasting, as outlined in the Federal Mine Safety Codes[5 6] and in Miners' Circular 58.[7]

INTRODUCTION

The use of short-delay blasting has been proposed for promoting safety and increasing the rate of production in coal mining. Ideally, short-delay blasting, as compared with equivalent single-shot blasting, reduces exposure of the shot firer to dust, fumes, and weakened roof; as compared with equivalent simultaneous blasting, it reduces roof disturbance.

In 1949 the hazards of gas and coal-dust ignition from multiple charges was evaluated by tests in the Experimental Coal Mine.[8] These experiments showed that the ignition hazard of permissible explosives fired at short-delay

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5/ Bureau of Mines, Federal Mine Safety Code for Bituminous-Coal and Lignite Mines of the United States, Part I - Underground Mines: Oct. 8, 1953, 86 pp.

6/ Bureau of Mines, Federal Mine Safety Code for Anthracite Mines of the United States, Part I - Underground Mines: Oct. 14, 1953, 48 pp.

7/ Bureau of Mines, Explosives Accidents in Bituminous-Coal Mines; Coal-Mine Accident Prevention Course, sec. 5: Miners' Circ. 58, rev. 1954, pp. 68-74.

8/ Hartmann, Irving, and Lewis, B., Experiments on Short-Delay Blasting in the Experimental Coal Mine: Trans. 41st Nat. Safety Cong., Chicago, vol. 7, 1953, pp. 36-44: Bureau of Mines Rept. of Investigations 5026, 1954, 6 pp.

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intervals was low, about the same as that for the present method of single-hole blasting; when initiation of the charges was simultaneous, the ignition hazard was greater than for single-hole or short-delay blasting. The preparation of present recommendations by the Bureau of Mines for short-delay blasting was delayed, pending consideration of the potential hazards of misfires and of cutoff charges (a cutoff charge is one that has been exposed through dislodgment of coal by a preceding shot).

To alleviate one of the main causes for misfires the Bureau developed a schedule 9/ for a permissible blasting unit providing adequate current for initiating 20 short-delay detonators wired in series. Current research by the Bureau indicates that the gas-ignition hazard of a cutoff charge is negligible when the precautions outlined herein are observed. 10/

ACKNOWLEDGMENTS

These recommendations were prepared jointly by the Bureau of Mines Divisions of Explosives Technology, Coal-Mine Inspection, and Safety. A special committee of the Institute of the Makers of Explosives and the safety directors of the Coal Mining Industry offered helpful suggestions.

RECOMMENDATIONS

General

Only specially trained and authorized shot firers should be employed for multiple blasting. The training should include instructions in (1) State laws, (2) company regulations, (3) the applicable Federal Mine Safety Codes, and (4) the recommendations that follow. Certification or authorization of shot firers should accord with State regulations.

It is good practice before blasting to test the electrical resistance and continuity of the shot-firing circuit with a suitable galvanometer (one having a silver chloride cell) (fig. 1). Because greater weights of explosive may be fired in a short time with short-delay blasting than with single-hole blasting, adequate ventilation should be provided in the face area to dilute toxic gases. It is advisable to test with a portable detector the CO concentration at the face after a round is fired, particularly during exploratory trials with multiple charges (fig. 2). A record of all misfires and hangfires should be maintained.

Face Preparation

Multiple blasting should not be done in mining toward and within 50 feet of an abandoned mine or an abandoned portion of a mine which cannot be inspected; this does not apply to multiple blasting of stumps in caving or in pillar-retreat mining.

9/ Bureau of Mines, U. S. Department of the Interior, Schedule 16D, Multiple-Shot Blasting Units: Federal Register, Sept. 27, 1958, vol. 23, No. 190, pp. 7533-7534.

10/ A Bureau of Mines report of investigations of current tests on the hazards of cutoff explosive charges in multiple blasting of coal is in preparation.

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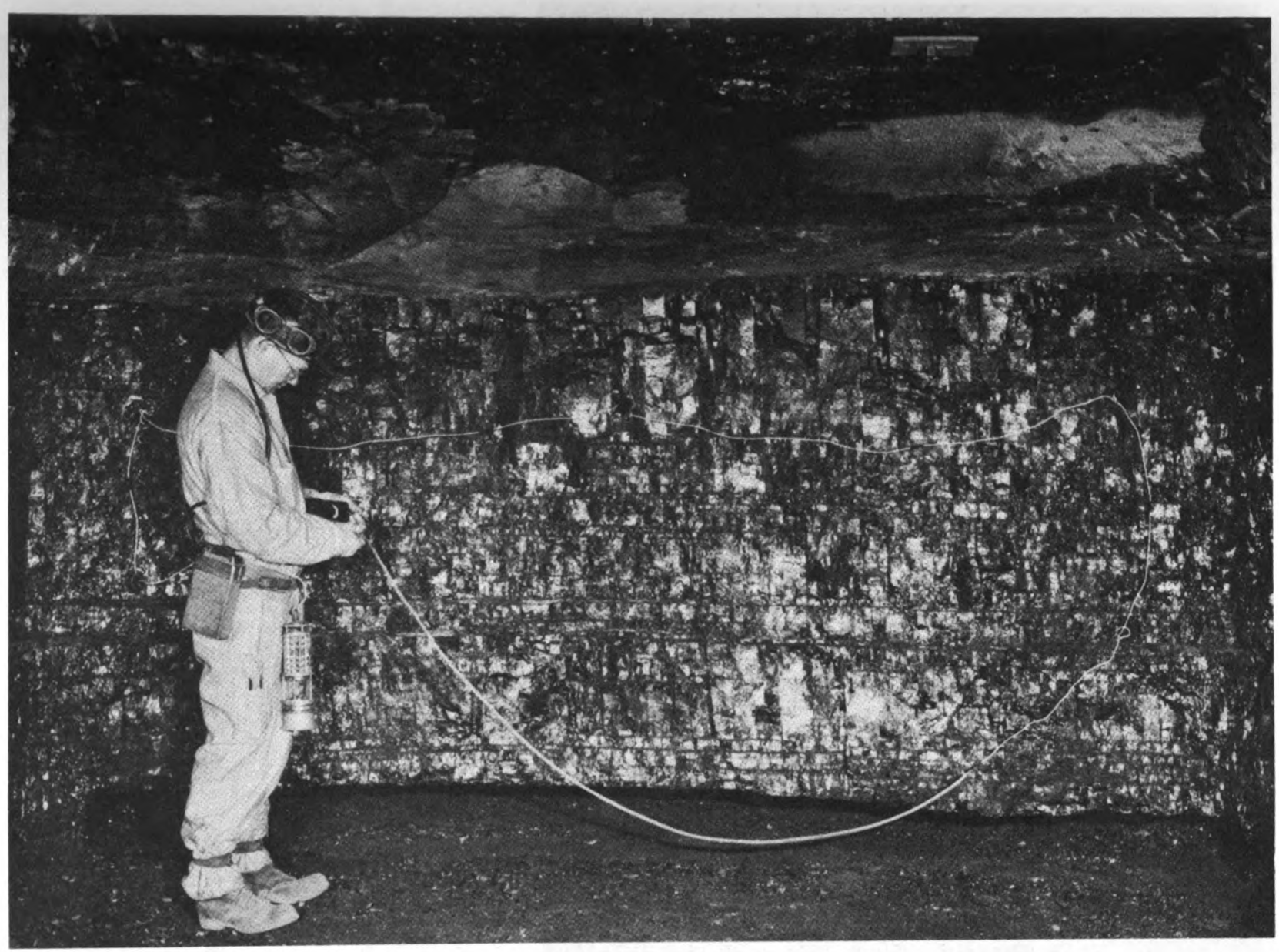

FIGURE 1. - Testing Continuity of Series Circuit for Short-Delay Blasting.

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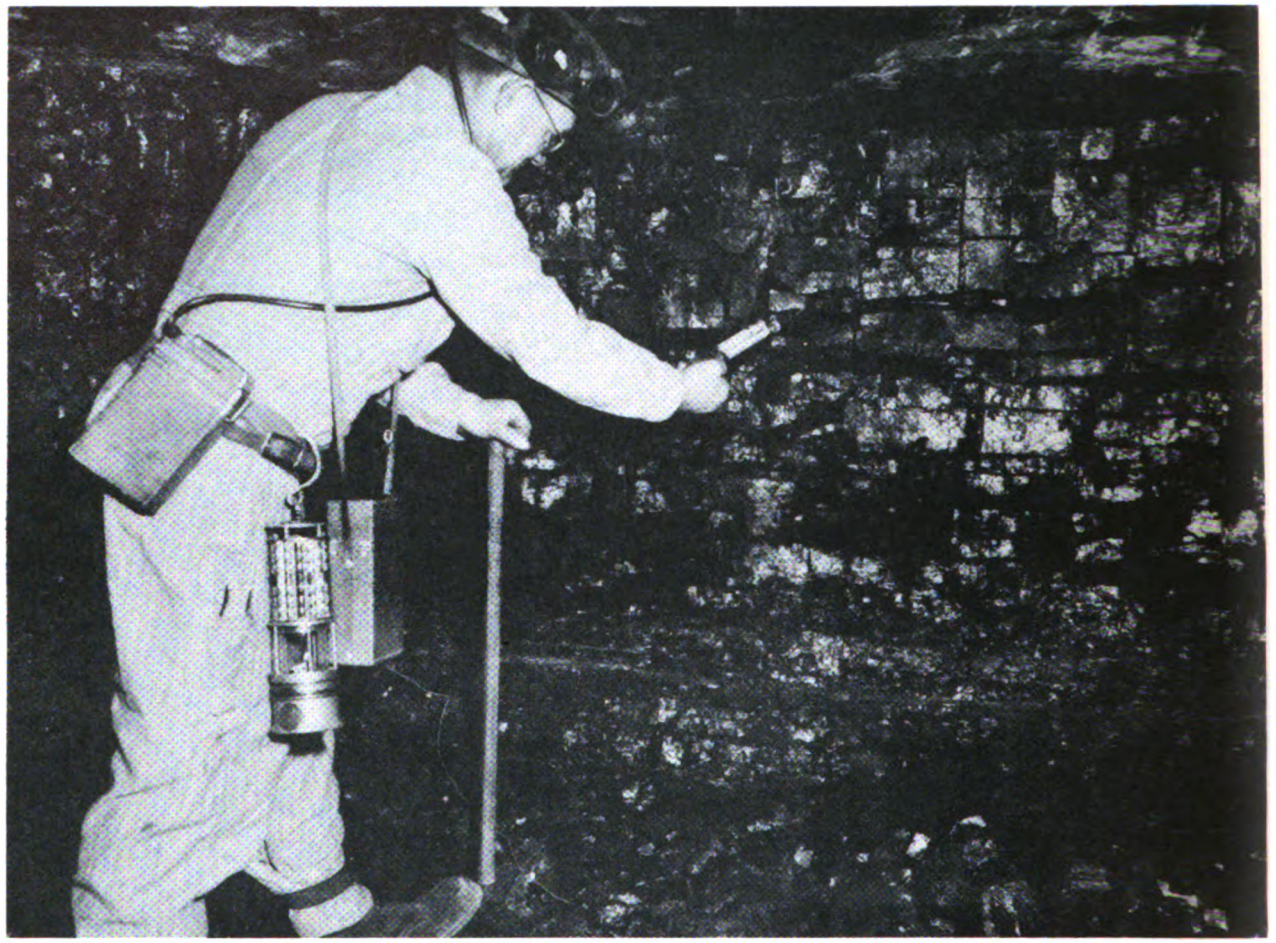

FIGURE 2. - Testing for Carbon Monoxide After Short-Delay Blasting in Coal.

Support of Coal

Where necessary, the coal should be supported after undercutting to prevent formation of cracks or fissures which might intersect shotholes and expose the charge. In such instances sprags should be left in place during blasting.

Depth of Cut

The minimum depth of cut should be 3 1/2 feet.

Number of Shotholes

A round should consist of not more than 20 shots.

Depth of Shotholes

The minimum depth of shotholes should be 3 feet. Holes for "opener" (or "buster" or "chance") shots should be drilled at angles not greater than 45° to the free face.

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Blasting Supplies

The blasting accessories for a round of holes primed with short-delay detonators should include the following:

(a) Short-delay copper-shell detonators of the proper periods and of one manufacturer, with copper leg wires or with iron leg wires not more than 16 feet in length.

(b) A permissible shot-firing unit specifically approved for short-delay blasting and of adequate capacity to fire all shots in the round.

(c) A shot-firing cable of not less than No. 16 gage insulated, duplex copper wire, 100 to 150 feet long, held on a nonmetallic reel.

Charging Shotholes

Time Delay

Neither instantaneous nor any of the so-called zero-delay detonators should be connected in a circuit containing short-delay detonators. The first shot in the sequence should be initiated by a short-delay detonator having a nominal delay period of not less than 25 milliseconds.

(1) When blasting cut coal, the nominal delay interval between successive shots or adjacent holes should not exceed 100 milliseconds. Care should be exercised in placing holes to avoid possible cutoff or exposure of the explosive charge in adjacent holes.

(2) When blasting coal off the solid, not more than two adjacent opener or cut holes should be primed with detonators having the same delay period. The nominal delay interval between the succeeding rows or horizons should be not less than 50 milliseconds or more than 100 milliseconds, except:

(3) When firing is done in raises (including chutes and breasts) the nominal delay interval between cut holes and relief holes, and between relief holes and trim holes, should be not less than 25 milliseconds or more than 75 milliseconds.

(4) When firing is done in thin-bedded rock detonators of the same delay period should be used to fire all holes in the same row or horizon. The difference in delay periods between shots in adjoining rows or horizons should be not less than 50 milliseconds or more than 75 milliseconds.

Preparation of Primer

In preparing the primer, which should consist of a detonator and a whole cartridge, care should be taken to insure that the detonator is inserted axially and does not protrude through the wrapping and that the leg wires are secured to the cartridge in a manner so that the detonator will not become dislodged in handling and charging. (See fig. 3, A and B.)

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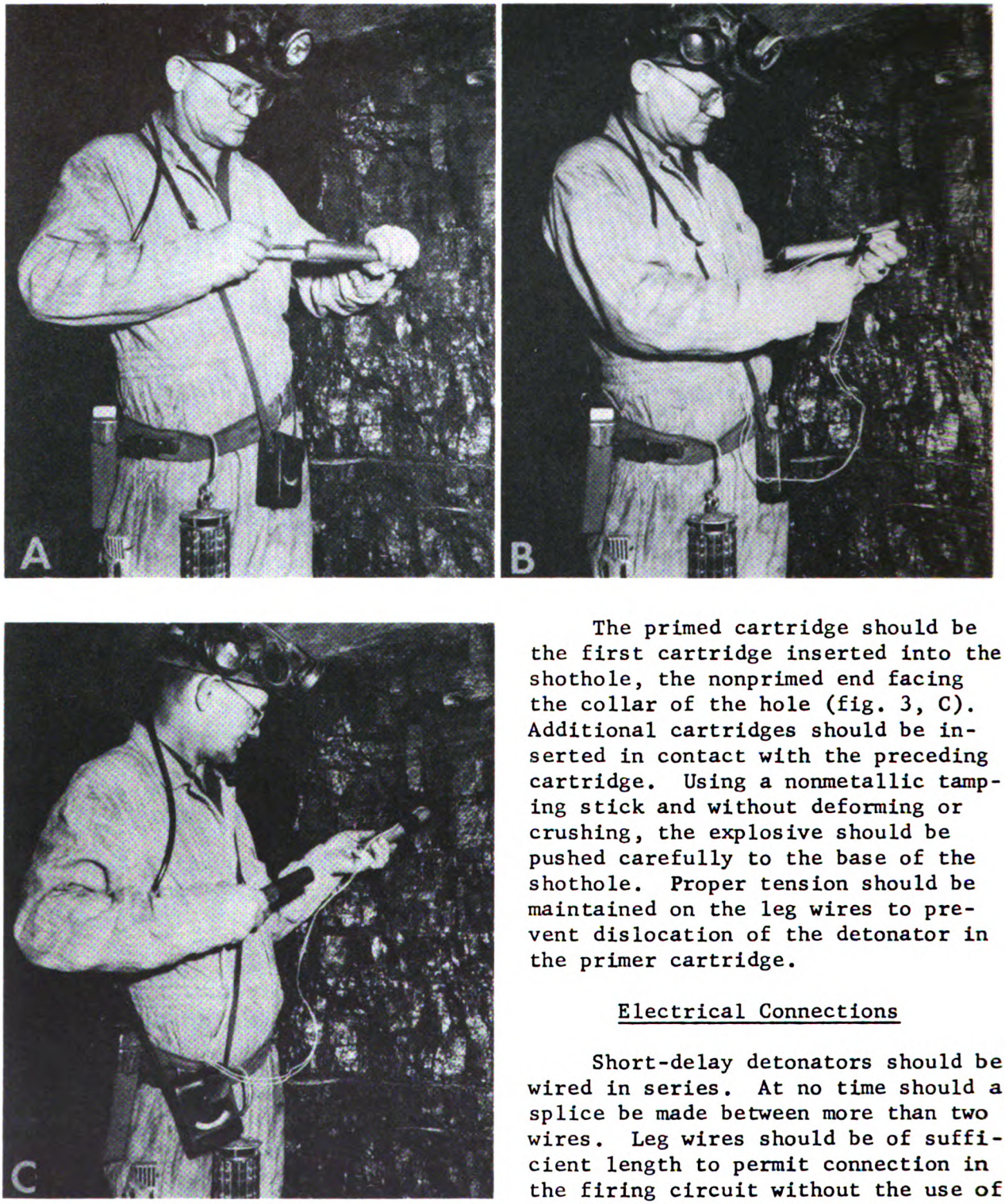

FIGURE 3. - Preparation of Primer and Charging Shothole for Short-Delay Blasting.

The primed cartridge should be the first cartridge inserted into the shothole, the nonprimed end facing the collar of the hole (fig. 3, C). Additional cartridges should be inserted in contact with the preceding cartridge. Using a nonmetallic tamping stick and without deforming or crushing, the explosive should be pushed carefully to the base of the shothole. Proper tension should be maintained on the leg wires to prevent dislocation of the detonator in the primer cartridge.

Electrical Connections

Short-delay detonators should be wired in series. At no time should a splice be made between more than two wires. Leg wires should be of sufficient length to permit connection in the firing circuit without the use of "jumper" wires.

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Only one person, an authorized shot firer, should remove shunts and make connections:

(a) The bare ends of the leg wires should be clean and the splices insulated.

(b) The detonator wiring should be checked before the shot-firing cable is connected. There should be one less splice between detonator leg wires than holes in the round.

(c) When possible, the shot-firing cable should be connected directly to the leg wires without use of an extension. When the shothole pattern prevents direct connection to the cable, an insulated wire without intermediate splices and of the same gage as the shot-firing cable should be used to extend one of the conductors of the shot-firing cable. This is illustrated in figure 4.

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FIGURE 4. - Use of Jumper Wire to Complete Shot-Firing Circuit.

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